Of the seventy-five, some said nothing about annual increment, a few gave the initial salary only, several gave both initial and maximum salaries, and some sufficient data to find the true average value of the salary over a number of years. This information has been used to deduce reasonable estimates of the prospects of advancement in other cases where the full data were wanting.

The posts were classified into three divisions, which comprised, roughly, (A) professorships, (B) lectureships, and (C) demonstratorships, or the equivalent of these, though of necessity a certain amount of discretion was used in the process. The average of the mean (not the minimum) salary in each class was then found, with the following result:—

Class	Number of vacancies	Average of mean salary £
A	16	620
B	22	385
C	37	234

The posts of the first class were nearly all at fixed salaries; those of the second started at, roughly, 320*l.*, rising to 450*l.*, per annum; those of the third went from an initial salary of about 200*l.* to 270*l.* These salaries probably give a fair idea of the value placed by governing bodies on the trained brain at the present day. They are undoubtedly higher than would have been the case in pre-war conditions, at least in the lower and middle of the two classes; but if the best brain-power of the nation is to receive full encouragement—and if labour difficulties are to disappear, production increase, and British civilisation advance, this can come only from full encouragement—these salaries are still far from adequate. Money has to-day little, if any, more than 45 per cent. of its purchasing power previous to the war. Salaries of 200*l.* and 600*l.* to-day bring their possessors no greater shares of economic goods than 90*l.* and 270*l.* in 1914.

It is beginning to be recognised—it is already recognised in the United States—that the elevation of the general level of prices is now more or less permanent, and that a return to a lower level, at least in this generation, is improbable, even if it should be desirable. The class of manual labourers has had its wages increased almost, if not quite, in proportion to the rise in prices. The mercantile community, working as it does on percentage margins, has made ordinary profits commensurate with that rise, and, in addition, has obtained unearned profits resulting from the rise itself. The class of fixed salary earners, which comprises the brain-workers of the nation, the professional class, has borne the brunt of the rising prices without anything like an adjustment of salary corresponding with the rise. It is the hardest hit of all by the war, and yet this class, perhaps more than any other, has contributed to winning the war. Hitherto patriotism has kept it silent. Now, however, the time has come when the scale of the professional man's salary must be revised. Incomes such as those found above do not admit of the upbringing and education of a family as befits its inherited ability; of the expenses inevitable if a man is to keep abreast of his profession; and of saving and insurance against sickness, age, and death.

"In war-time," writes the *Economist* of July 12, in a "business note" on British and German science, "we make full use of our men of science. If we did so in peace they might be as useful for production as they have been for destruction." The first step is to see that they get what, for them, is a living salary, else there will be no men of science to use. The second step is to see that their teachers get adequate remuneration, else there will be no training to make men of science of them. C.

MODERN SINGLE-OBSERVER RANGE-FINDERS.

THIRTY years ago the War Office asked for a rangefinder for field service that would measure ranges to within 4 per cent. at 1000 yards—that is, 40 yards at 1000 yards, or 160 yards at 2000 yards. A single-observer rangefinder of 30 in. base was designed to fulfil these requirements. In 1892 a naval rangefinder was required that would work within an error of 3 per cent. at 3000 yards, which is equivalent to 1 per cent. at 1000 yards. This demand was met by a rangefinder of 4 ft. 6 in. base. Whereas in 1895 the effective range of naval gunnery was between 2000 and 3000 yards, the effective range in 1904 was 6000 yards. For this service a rangefinder of 9 ft. base was introduced.

At the Battle of Jutland in 1916, firing commenced at a range of more than 20,000 yards, and although the makers had already constructed rangefinders of 15 ft. to 35 ft. base, the majority of the Service rangefinders were still of 9 ft. base, the Fifth Battle Squadron alone having been equipped with 15 ft. base rangefinders capable of measuring a range of 20,000 yards to within 170 yards, an error equivalent to 18 in. at 1000 yards. The 30 ft. base rangefinders exhibited by Messrs. Barr and Stroud, Ltd., at their stand at the British Scientific Products Exhibition are designed to work within half this error (Fig. 1).

Thus in the development of single-observer rangefinders during the past thirty years, the uncertainty of observation has been reduced from 40 yards at 1000 yards to the equivalent of 9 in. at 1000 yards; that is, the accuracy has been increased 160-fold.

This increase of accuracy has been obtained by increasing the base length about 12-fold and the magnification about 3-fold, thus accounting for a 36-fold increase. The remainder of the increase has been attained by refinements in the design and construction of the optical and mechanical elements based upon the results of research work conducted continuously during many years by a large staff of scientifically trained observers.

The accuracy of observation when using a coincidence rangefinder is ultimately dependent upon the accuracy with which the eye can detect a want of alignment between the partial images of the object in the field of view, and this largely depends upon the manner in which the images are presented for observation. As a result of much experience and many experiments on the alignment of images as presented in the Barr and Stroud rangefinders, it would appear that, under ordinary good conditions of observation, a want of alignment between the images can be detected when they subtend at the eye an angle of about 12 secs., *i.e.* 0·0000582 in circular measure, although frequently a much smaller angle can be resolved.

If B is the base of the rangefinder, M the magnifying power, and R the range, then

$$\delta R = 0{\cdot}0000582\, R^2/MB.$$

From this formula it will be seen that, to decrease the error δR at a particular range, either the magnification M or the base length B must be increased. In practice the magnification is limited by the permissible size of the optical parts and the necessity to provide for range-taking in dull light, by the quality of the optical glass, and by external circumstances such as mirage due to the intervening atmosphere. At the present time a magnification of more than 30 diameters is not desirable. When this maximum magnification is provided, the required accuracy of observation is then obtained by increasing the base length.

At the commencement of the war no British battleship carried a rangefinder of greater base than 9 ft. This base had been decided upon in 1904, when the maximum effective range for the opening of fire was generally assumed to be not greater than about 6000 yards. In the Battle of Jutland fire was carried out at ranges above 20,000 yards. The *Iron Duke,* which carried only 9 ft. rangefinders, opened fire at 12,000 yards. The rangefinders were, therefore, called upon to perform a duty at least four times as onerous as that for which they were originally designed. It will be understood that the substitution on existing ships of the larger types of rangefinders available involved extensive structural alterations that could not readily be carried out, and it is only within very recent years that the importance of rangefinding has been recognised as being sufficient to justify the ships being designed for the accommodation of rangefinders most suitable for the guns.

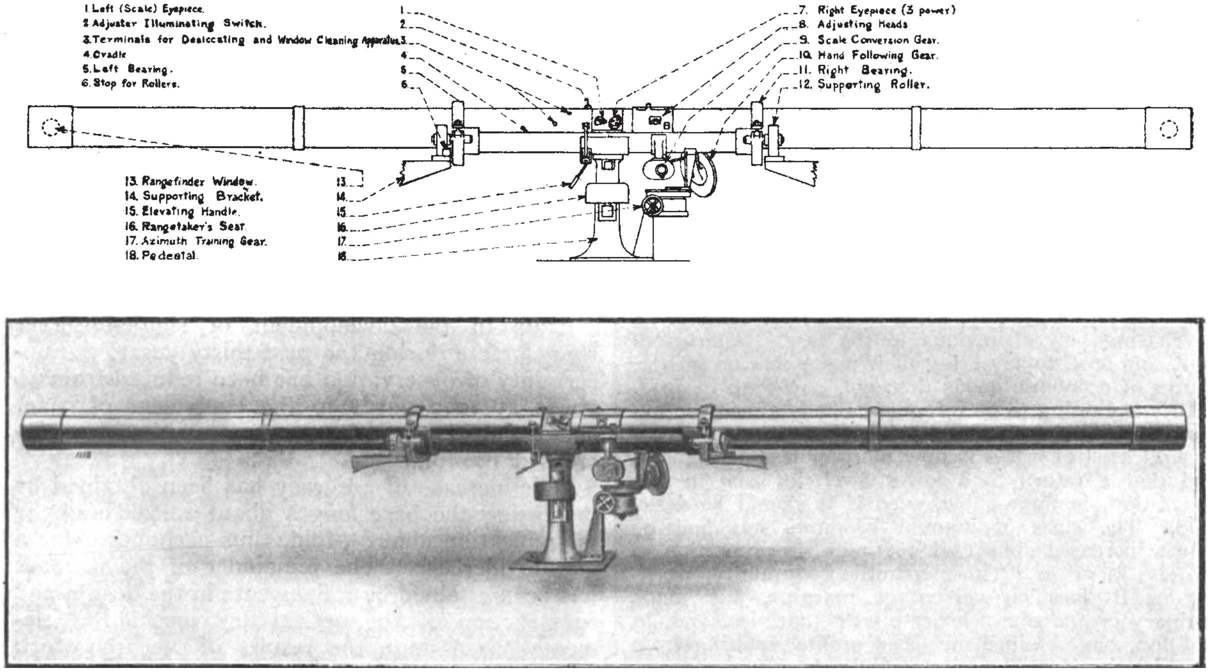

FIG. 1.—Naval rangefinder type F.X. with uniform range scale accessories. Base length 30 ft.; Magnifications 16, 20, and 28; uncertainty of observation under good conditions 330 yards at 40,000 yards range.

Notwithstanding the use of 9 ft. rangefinders in association with guns, the power of which has been so greatly developed during the last twelve years, the British Fleet at the Battle of Jutland defeated the German ships, which there is good reason to believe were equipped with rangefinders of 20 ft. base and, probably, to some extent 33 ft. base. In such circumstances it is not surprising that the German rangefinding was excellent: it is more surprising that it was not very much better and that its excellence was confined to the first stage of the action.

It should be observed that, for a given gun, the longer the range the more necessary it is to know the range accurately, on account of the greater angle of descent of the projectile—that is to say, an error of 100 yards in range has a much greater effect on the percentage of hits at 24,000 yards than at 6000 yards—but a rangefinder gives errors varying according to the square of the distance. The problem of finding a range of 24,000 yards within 100 yards is sixteen times as difficult as the finding of a range of 6000 yards within the same limit.

The modern rangefinder differs from the earlier types in the size of the optical parts and, consequently, of the mechanical parts, and in the provision of internal adjusting devices and of such accessories as variable power eye-pieces, light-filters, and apparatus involving complicated conical gearing for the conversion of the reciprocal scale into a uniform scale of ranges. Considerable improvements have been effected in the mountings, which are necessarily designed to suit particular requirements and the structural arrangements of the ships. Provision is now generally made for three operators, namely, the rangetaker, who also controls the rangefinder in elevation; the trainer, who is provided with a special sighting periscope; and the scale reader, who transmits the ranges to the fire control station.

The advent of aerial craft has necessitated the use of special combined range and height finders which automatically determine the height of the target from its range and elevation. In the case of naval anti-aircraft instruments, the vertical from which the elevation is reckoned is defined by means of a damped pendulum device. Anti-aircraft height finders for land purposes have the advantage of a steady platform, and in some respects the problem is simpler, as the horizontal can then be determined with sufficient accuracy by means of a good spirit level provided upon the mounting.

Whereas the range of an approaching aeroplane changes so rapidly as to make the operation of maintaining the coincidence of the partial images in the field of view of a rangefinder a matter of some difficulty, the height of the aeroplane remains comparatively constant for considerable periods. It is generally more convenient, therefore, to measure the height, from which the setting of the gun can be readily adjusted in relation to a suitably engraved gunsight scale. As the range is a function of the elevation when the height is constant, an arrangement has been devised whereby the partial images of the moving aerial target are kept in coincidence by the simple operation of following the target. For this purpose, the elevating gear is arranged to act upon the deflecting prism of the rangefinder through the intermediary of conical spiral gears, which are equivalent to cams of the requisite form. If the height alters, the partial images can be brought again into coincidence by independent direct operation of the working head. Both heights and ranges are indicated by the instrument, the latter being better suited to gunnery purposes when the aircraft appears at a long distance over the horizon.

The problem of hitting enemy aircraft at long ranges is greatly complicated by the necessity of taking account not only of the interval that must elapse between the finding of the range (or height) and the setting of this upon the gun-sights and the laying of the guns, but also of the greater interval between the time of firing of the gun and the arrival of the shot at its destination. The gun has to be sighted and laid, not for the aşcertained position of the target, but for the position that it may be expected to occupy after an interval, it may be of thirty seconds or more, during which time the target may have travelled 1000 or even 2000 yards from the position that had been determined. The new and difficult problems thereby involved have already been solved, more or less completely, by the invention of predicting instruments closely associated with the range and height finders.

JAMES WEIR FRENCH.

THE BOURNEMOUTH MEETING OF THE BRITISH ASSOCIATION.

THE eighty-seventh meeting of the British Association for the Advancement of Science will this year be held at Bournemouth, under the presidency of the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., on September 9–13. The last meeting was held at Newcastle-upon-Tyne in 1916, the 1917 and 1918 assemblies having been abandoned owing to obstacles brought about by the war. This was the first break in the annual meetings of the Association since its inception in 1831. With the return of peace and happier conditions, it is anticipated that the Bournemouth meeting will be a successful and memorable one.

A strong local executive committee, with the Mayor as chairman, has been energetically at work for some months. The preliminary arrangements are well advanced, and every effort is being made to ensure the complete success of the meeting. So far as organisation is concerned, nothing is likely to be lacking, and it only remains for those interested or engaged in scientific work to take full advantage of the opportunities offered to them. Already the number of applications for election as annual members and associates is considerable, and doubtless as the date of the meeting approaches it will increase rapidly

The Association will find a home in the Municipal College, a fine building, centrally situated, which was erected shortly before the war. Practically the whole of the college rooms will be placed at the disposal of the Association for the week, and will afford ample and conveniently centralised accommodation for its many and varied activities. Only the large public assemblies —the inaugural general meeting, at which the president's address is delivered; the discourses by Sir Arthur Evans, F.R.S., and Mr. Sidney G. Brown, F.R.S.; and the usual conversazione—will be held elsewhere. The Winter Gardens Pavilion, which is capable of seating an audience of upwards of 1200, will be the scene of these functions.

The programme of work is very full, and the week will be one of great activity. For the serious worker there will, as always, be many interesting papers and discussions, while the rumour that hitherto carefully guarded secrets of the work of men of science in the war will be made known for the first time is sufficient to appeal to the imagination of the general public and to focus attention upon the meeting.

Social functions will not form a marked feature of this meeting. The only official entertainment on a large scale will be the conversazione at the Winter Gardens on September 10. But Bournemouth is widely famous for its manifold attractions, and members and associates will have no difficulty in finding numberless opportunities for relaxation and amusement in their leisure hours.

In a popular seaside resort in September the pressure on the available accommodation will probably be great. Those attending the meeting